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American Meteorological Journal.

A Monthly Review of Meteorology and Allied Branches of Study.

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THE AMERICAN

METEOROLOGICAL JOURNAL.

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EDITORIAL NOTES.

THE October number of the JOURNAL was delayed by negotiations for a change of ownership. This paper is now the property of Mr. K. Kittredge and the editor. All communications should hereafter be directed to Ann Arbor; those relating to business matters to the METEOROLOGICAL JOURNAL Co., and those relating to editorial matters, including everything relating to contents of the paper, exchanges, and reviews, to the editor.

WE think that our readers are now in a condition to judge for themselves as to the value of the predictions of Mr. Sherman and Mr. Clayton, and that, at the present, further publication would serve no useful purpose. We think each has shown a good measure of success and that together they have called attention to weather conditions which deserve, and will doubtless receive, the attention of meteorologists. Meantime we open our pages to each of our predictors for his own estimate of the accuracy of his predictions, and to the criticisms of our readers.

CURRENT NOTES.

PENETRATION OF LIGHT INTO WATER.—Messrs. Fol and Sarasin have tested the depth to which light penetrates by sinking sensitive plates and exposing them for a uniform time but at different depths. They find that in the Mediterranean Sea the last glim-

mer of light disappears at a depth of 400 metres, while on Lake Geneva the limit of penetration of daylight is only about 200 metres. A very curious fact had been previously obtained by M. Ford. He found that sensitive paper, sunk in Lake Geneva, was blackened at the depth of 100 metres in winter, but was not affected at 45 metres in summer. Probably this is due to the varying quality of matter held in suspension by the water. It must be in much larger quantity in summer than in winter.

EXPLOSIVES AS TORNADO-DESTROYERS.—In a recent number of the *Scientific American*, Mr. John F. Schultz publishes a letter in favor of the use of gunpowder, or other explosive, for the control or annihilation of tornadoes. He believes that a keg or barrel of powder, kept southwest of the buildings or village to be protected, and exploded at the proper instant, would either break up the tornado or cause it to jump so great a distance as to effect the protection desired. This is all possible, and it only remains to show that it is actual and practicable. In all such cases there is a great distance between what may be, and what is, and in this case the step between the two is a particularly large one. If the idea—promising as an idea—is really valuable practically, it would be easy to construct an automatic arrangement for the explosion of the powder at the proper instant.

THE TENNESSEE WEATHER SERVICE has been undergoing various vicissitudes lately. It was connected with the State Bureau of Agriculture until a few months ago, when its reports were published by the *Spirit of the Farm*, an agricultural journal printed at Nashville. The July report appears again as a pamphlet, but this time as the *Bulletin* of the State Board of Health. Major H. C. Bate still continues in direct charge of the meteorological work.

PROFESSOR PALMIERI'S CONCLUSION.—Prof. Palmieri, of the Vesuvian Observatory, finds that the atmospheric electricity is usually positive in clear weather; if negative, a fall of rain may be inferred to be in progress at some little distance. Two maxima and two minima daily are noticed in the electric indications, this periodicity being disturbed by atmospheric movements. With

dew, rain or an overcast sky the indications increase in intensity, and are stronger in spring and autumn than in summer and winter. A rain zone is positive, but is surrounded by a negative zone, which in turn is surrounded by a zone of positive electricity, Thunder and lightning, according to this observer, did not occur without rain.

THE METEORITE OF CANONCITO.—This is a mass of nearly 320 pounds, found early in 1884, by a prospector on the Glorieta mountains southeast of Santa Fe, New Mexico. The mass was in three pieces, lying on the rock, and showed little sign of weathering. It probably fell recently, and, in this sparsely settled district, its fall might have easily escaped attention. It has been examined by Mr. George F. Kunz, who found it a common form of iron meteorites. A curious feature was that it could have fallen on rock and been so little fractured. It may have reached the ground in a semi-plastic condition.

PECULIARITIES OF TEXAS RIVERS.—The Texas river is an institution that is peculiarly Texan. In the southern portion of the state many of the river and streams manage to get along during the summer with very little water. Near El Paso it has frequently occurred that the natives have had to dig wells in the dry beds of the Rio Grande in order to get drinking-water. For two miles the river bed was as dry as two volumes of *The Congressional Record.*

The writer has crossed the Nueces river without knowing it. The dust was so thick that he did not perceive that the road crossed the dry bed of the river. About two hours after he crossed the Nueces river without knowing it a tidal wave six feet high came rolling down that river bed. Six hours afterward the river had risen thirty feet and before twenty-four hours had passed away the river in some places was upward of three miles wide, and at the place where I stirred up the dust the raging waters were deep enough to float the Great Eastern.

The Cibolo is a creek, between Austin and Antonio, that for many miles runs almost altogether underground. It consists of a succession of pools. The water sinks out of sight and reappears a mile or so distant. The banks of the Cibolo are quite steep,

and in some places are forty or fifty feet, which makes it very difficult for wagons to cross, particularly in wet weather.

The San Antonio, Comal, San Marcos, Guadalupe, Brazos, and Sabine rivers do not become actually dry, but in the summer they, like the republican majority in many states, dwindle away to almost nothing. The statement that the water gets so shallow that the catfish have to stand on their heads and fan themselves with their tails to keep cool, is exaggerated a little.

The habit the Texas rivers have of rising sixty feet in twenty-four hours makes the building of railroads very expensive in Texas. The bridges over the apparently most insignificant streams have to be made very high and of the most durable material.

When a stranger sees an immense bridge over a stream he is inclined to suggest that the people sell the bridge and buy some water to put in the creek; but after there has been a rise it would be more appropriate to sell some water to buy a new bridge.—*Texas Siftings.*

A Storm-Predicting Well.—J. P. Grafton, of Woodland, informs Sergeant Barwick, of the United States Signal Service in this city, that he has upon his ranch, which is situated six miles west of Dunigan, in Yolo county, a well, in the center of a small valley on the edge of the low hills, that gives warning from two to three days in advance of a storm, and whether the storm is to be a continued one with heavy rainfall, or whether it is simply one of appreciable precipitation. This well is one of six-inch bore, 146 feet to the water, and having a total depth of 160 feet. It will have been sunk about two years next October. This particular well will, in two or three days in advance of a storm of heavy precipitation, give out a roaring sound resembling the noise of water at a cascade as it goes tumbling and rushing down and over the rocky surface to its bed below. This waterfall, racket-like noise or roaring continues until the storm approaches, decreases as the storm passes, and finally ceases altogether and conducts itself as other well-behaved wells usually do. The water of this well is pure, soft, and pleasant to the taste, and is raised to the surface by a hand pump. The well is piped very near to the bot-

tom. When an atmospheric disturbance of small dimensions is approaching, and for two or three days in advance of its rain-producing quadrant, this well will begin to make a hissing noise resembling somewhat that produced by escaping steam. The internal commotion of this well can be plainly distinguished at a distance of one hundred yards, and voices some distance off appear to a person standing at the well to come from the depths of this roaring, hissing and storm-predicting curiosity. Mr. Grafton would be pleased to have this terrestrial phenomenon thoroughly tested and examined, and is willing aud ready at any time to assist any one, scientifically inclined, who desires to investigate. The gentleman says this well of his began giving off a hissing or sighing noise about the 2d or 3d of the present month, and we all know of the rain-storm in the mountains that gave such a fine display of atmospheric electricity on the 5th, and rain fell at San Francisco and Los Angeles on the 5th and 6th, although the amount was inappreciable; but at Cape Mendocino there was .11 of an inch, and quite a storm in Washington Territory and Oregon. Mr. Grafton informs the Sergeant that he is an old timer, and has been in this State about 33 years, lived four years in Sacramento, but has been residing in Yolo county since 1857. If the facts regarding this well are as stated, and the phenomena are steady and reliable, it could be put in telegraphic or telephonic communication with Sacramento, and by having an observer of acute and sensitive hearing, could reliably predict, forecast or foretell the approach of rainfall, both heavy and light. This being the fact, California would take rank as having one of the most wonderful and beneficial (to mankind) natural curiosities that exists in the world, and cause tourists and all the others to stop over, especially in the winter, and visit the only simon pure and never failing Wiggins of the West.—*Sacramento Bee.*

For more than a year some important measurements of the altitude and movements of clouds have been carried on at Upsala by the aid of two theodolites, one of which is mounted in the Linnæus and the other in the Botanical Gardens. These instruments, which belong to the Academy of Science, were used for auroral and cloud measurements by the Swedish expedition to

Spitzbergen, 1882–3. The object of the measurements of the altitude and movements of clouds is not so much to obtain their mean altitude as to derive some knowledge of their movements in the upper part of the atmosphere, a matter which is of great importance to meteorology. The researches have advanced so far that it has been found possible to fix, astronomically, the movements and altitude of the cirrus clouds.—*Nature.*

REVIEW OF EUROPEAN WEATHER FOR JULY.—*Barom. pressure.*—On the 1st there is a high pressure over west central Europe and a depression over Scandinavia. The latter disappearing on the 3d, the high pressure spreads also over northern Europe, with some small minima over western Germany and France, causing some precipitation. Another maximum appears S.W. of England on the 4th, while a very extensive depression is approaching in the NW.; the weather by this time is clear and calm after many local rains and thunder-storms in Germany; on the 8th the minimum in the N.W. recedes and the high pressure in the S.W. spreads over Germany to Russia, with high temperature. and is situated on the 11th near St. Petersburg; a slight minimum west of Ireland travels north-easterly and hovers on the 13th over north Scandinavia; the highest temperature is also found in N.W. Russia; a new disturbance appears on the 15th N.W. of Scotland, and slight depressions with rainfall travel over Germany; the minimum in the N.W. has traveled north-easterly and hovers on the 18th over Scandinavia; another follows, rapidly traveling to the S.W. shores of Norway, causing strong to stormy winds in its vicinity, and on the 20th is seen over Denmark, disappears on the 23d, and in its place high pressure extends to north Norway; a minimum has now developed over Russia, and on the 24th is situated near Momel on the Baltic coast, causing strong to stormy winds and precipitation over the Baltic and its vicinity. Calm, clear weather with temperature below the mean extends from Germany to west Britain. After causing much precipitation over western Russia the depression just spoken of has traveled in a south-easterly direction and hovers over southern Russia till the end of the month. (Barometer at Odessa on the 29th, 29.2.) By this time the pressure in the west has increased to 30.3 (Aberdeen).

Temperature: Germany.—Below the mean: 1–4 and 23–31; above the mean, 5–22; highest on the 14th, at Breslau, 88°; lowest on the 23d and 24th, at Hanover, 52°.

Ireland: Valentia.—Below the mean: 1–4, 6–9, 11–22; above the mean, 5, 10 and 22–31; highest on the 28th, 75°; lowest on the 11th, 54°.

Russia: St. Petersburg.—Below the mean: 2, 19–30; above the mean, 1, 3–28, 31; highest on the 14th, 16th, 18th and 24th, 86°; lowest on the 29th, 54°.

Sweden: Stockholm.—Below the mean: 1. 23–31; above the mean, 2–22; highest on the 14th, 81°; lowest on the 24th, 50°.

Lapland: Hoparanda.—Below the mean: 1–3, 6, 22–31; above the mean, 4, 5, 7–21; highest on the 14th, 71°; lowest on the 31st, 50°.

Erratum.—In the review for May is to be read: Barometer at Hurst Castle, 20.1 M. BUYSMAN.

MIDDLEBURG, HOLLAND.

MEASUREMENTS OF TEMPERATURE BENEATH THE EARTH'S SURFACE.—It is supposed that it is very hot in the middle of the earth; and the Germans, like a philosophical people, are now going to some expense in order to find out how hot it is. Now we are not without some of those clever guesses called scientific inductions. The French have their own views on the subject, so have the Austrians, so have we. But in these cases the information obtained, such as it is, has been arrived at in the pursuit of something else. It is more noble to go to the cost of obtaining knowledge for its own account; and it strikes us as almost unfair to the Germans that the heat as indicated by their boring should be less than that calculated on any other data.

It is generally held that at a depth of fifty feet an underground zone is reached in which the temperature is the same all over the world and at all seasons of the year. And this temperature is said to be 50 (or, to be more accurate, 50.5) degrees of the thermometer of Fahrenheit, 180 of which degrees measure the difference between the temperature of boiling and of freezing water under ordinary conditions.

A well sunk to the depth of 1,802 feet at Grenelle, a suburb

of Paris, took seven years and two months of difficult labor to complete: and, when the water-bearing stratum was reached, the water rushed up with such force as to rise 120 feet above the surface. This water was observed to have a uniform temperature of 81.8 degrees Fahrenheit, showing an increase of temperature at the rate of 1 degree of Fahrenheit for about every fifty feet below the neutral zone above mentioned. At Kissingen, in Bavaria, a brine-well has been bored to a depth of 2,000 feet. But the water has only a temperature of 66 degrees. In Algeria the temperature of 79 degrees Fahrenheit is shown by water springing from borings of not more than 280 feet. But this was said to be a miracle. The artesian wells in Chicago are 700 feet deep, and have a temperature of only 57 degrees Fahrenheit.

Measurements of temperature not absolutely dependent on the flow of water are more consistent in their results than the above. In the Cornish mines the temperature increases one degree for every sixty feet. In the Dukinfield lead-mine the increase is one for every sixty-three feet. At Rosebridge, near Wigan, a temperature of 92 degrees Fahrenheit is found at a depth of 2,376 feet. At La Mouille bores, near Creuzot, at a depth of 3,017 feet, the temperature recorded is 110.2 degrees Fahrenheit. The new German boring is made near Schladebach; the depth reached is 4,566 feet, and the temperature note 120 degrees Fahrenheit. The respective increase of temperature in the last three cases is a degree of 56, in 53.5, and in 65 feet; so that either the earth is much cooler near Schladebach than in England and in France, or for some other reason the result of the German boring indicates a slower rate of increase of temperature than either of the above cases cited.

At the Cornish rate of increase, which is pretty nearly a mean of the various estimates, the temperature at which water boils will be prevalent at a depth of less than two miles below the surface. At a depth of fifty-four miles, which is less than one-seventieth part of the distance to the center of the earth, the temperature of the combustion of ordinary coal must prevail if the law of the increase of temperature with depth remains constant. To go any further, to indicate in degrees of the thermometer the theoretic heat at the center or any other point, is nothing but

scientific trifling. Nor is any great practical good likely to result from experiments to show whether, in any given spot, temperature increases with every fifty-three feet or with every sixty-five feet that we burrow in imagination below the soil.

There is, however, a certain object in attempting to discover the approximate law of increase of temperature with depth. In 1871 a report was presented to parliament from "the commissioners appointed to inquire into the several matters relating to coal in the United Kingdom." The commissioners took the eminently practical view that, "looking to possible expedients which the future may elicit for reducing the temperature, they consider that it might be fairly assumed that a depth of at least 4,000 feet might be reached." At this depth the temperature probably exceeds 122 degrees Fahrenheit. As to its "reduction," it is to be remembered that the heat, whatever it be, is not that of the air alone, but that of the earth on and within which the miner has to stand or to lie; and that, as to "reducing" it, it is fed from reservoirs of the capacity of the globe.

At the temperature of the blood, which is 98 degrees Fahrenheit, continous exertion is impossible to the European. This temperature is reached apparently at a depth of about 2,690 feet; which is 314 feet lower than the deepest colliery in England. But long before the impossible is attained the costly and the difficult commence. A temperature of 80 degrees Fahrenheit is probable at a depth of 1,800 feet. Far within this limit, in the Monkwearmouth mines, at a depth of 1,640 feet, shorter hours are required for the miner, the cost increases in proportion. These considerations reduce the rationally probable contents of our coal-measures (those known to exist in the United Kingdom) from the 90,000,000,000 of tons estimated by the commissioners to 39,000,000,000 of tons extractable with our present means; and we are bringing it to the surface at the annually increasing rate of 160,000,000 of tons per year. The supply will last our time, no doubt; but centuries are but small periods in the life of a people. And it is easy to see that, on such information as we have, it is not for centuries in the plural that our coal-supply will hold out, if we continue its ever-increasing extraction.—*St. James's Gazette.*

A PRELIMINARY EXAMINATION OF METAL THERMOMETERS.

When the attention of the writer was first called to metal thermometers, little confidence was felt in the reliability of the claims put forward for them even as approximate indicators of the temperature. Much less was the expectation that they could in any sense be regarded as instruments of precision. A brief trial, however, of an instrument manufactured by the Standard Thermometer Co. of Peabody, Mass., gave results so surprisingly good that it was considered worth while to make a more extended investigation. Application was therefore made to the manufacturers of these thermometers for the loan of a sufficient number of instruments, taken at random from the stock on hand. Four thermometers were in consequence sent to the Observatory for trial. Two were of the smallest pattern made, with movements enclosed in case. The remaining two were of a larger size and had an exposed movement.

Since these thermometers were received, decided improvements of construction have been introduced, mainly by the introduction of a steel bridge which supports the movement. About four weeks since, five thermometers of this class were kindly placed at my disposal.

The present discussion relates to the thermometers first received with the exception of two which were used in one experiment. A second paper will follow, when the present experiments are concluded. It is the intention to make continuous observations for about six months.

The present series of observations will comprise:

(1) A continuous series of evening comparisons of thermometers enclosed in case and designated M_1 and M_2 with the standard thermometer of the observatory, designated "No. 4."

(2) Half hour comparisons of M_1 and M_2 with No. 4, and a new Cassella Thermometer, designated C_1 on May 28 and May 29, 1885.

(3) A comparison of the open thermometers M_3 and M_4 with Baudin 8614, reduced to the Yale Standard, under continuous exposures of the thermometer to the temperature of the new room

for the comparisons of standards of length situated beneath the rotunda of the observatory.

(4) Comparison of M_1 and M_2 and also of thermometers M'_1 (closed case) and M'_2 (open) of the new pattern, with C_1, under rapid changes of temperature.

FIRST SERIES.

The observations of this series were taken in connection with the regular observations with the Meridian Circle. M_1 was placed beside No. 4, and at nearly the same height from the ground. The first column contains the corrected readings of "No. 4" and the second column, the readings of M_1 and M_2 as they were taken at the time. Where more than one comparison was made on the same day, the interval between the comparisons was about one hour.

Date.	"No. 4."	M_1	No. 4—M_1	Date.	"No. 4."	M_1	No. 4—M_1	Date.	"No. 4."	M_2	"No. 4—M_2
1885.				1885.				1885.			
Mar. 12...	10°.6	13°.2	—2°.6	April 14...	42°.8	43°.9	—1°.1	May 10...	47°.9	49°.1	—1°.2
"	9.8	11.9	—2.1	"	39.2	40.1	— .9	"	48.1	49.2	—1.1
"	8.8	10.8	—2.0	" 15...	45.8	46.8	—1.0	"	45.7	46.9	—1.2
" 14...	26.6	28.8	—2.2	" 16...	43.8	44.8	—1.0	"	43.7	44.8	—1.1
"	25.6	27.2	—1.6	" 17...	42.4	43.2	— .8	" 16...	51.7	52.7	-1.0
"	25.0	26.7	—1.7	" 25...	51.7	52.9	—1.2	"	48.9	50.0	—1.10
" 17...	15.0	16.1	—1.1	"	50.5	51.6	—1.1	"	47.4	48.4	—1.0
" 18...	19.2	19.8	—0.6	" 27...	57.5	58.6	—1.1	"	46.1	47.3	—1.2
"	16.5	17.2	—0.7	"	56.1	57.3	—1.2	" 17...	48.5	49.7	—1.2
"	15.9	16.3	—0.4	"	54.1	55.1	—1.0	" 21...	55.7	56.1	—1.4
" 19...	26.8	28.4	—1.6	" 30...	57.9	59.1	—1.2	"	54.7	55.6	—0.9
"	21.2	22.1	—0.9	"	55.8	57.2	—1.4	"	53.3	54.1	—0.8
" 21...	13.3	14.1	—0.8	"	53.3	54.2	— .9	" 26...	67.4	67.9	— .5
"	13.6	14.4	—0.8	May 2...	46.4	47.5	—1.1	"	67.4	67.6	—0.2
" 23...	21.5	22.4	— .9	"	44.6	45.7	—1.1				
"	21.1	22.2	—1.1	"	42.9	43.9	—1.0				
" 25...	27.8	28.9	—1.1	"	44.3	45.2	— .9				
"	26.6	27.6	—1.0	"	42.3	43.2	— .9				
"	25.6	26.9	—1.3	" 3...	42.7	43.7	—1.0				
" 28...	40.3	41.2	—0.9	"	40.4	41.5	—1.1				
"	38.9	40.1	—1.2	"	39.2	40.4	—1.2				
" 29...	26.1	26.9	— .8	"	38.5	39.6	—1.1				
"	25.1	25.9	— .8	" 9...	47.9	50.0	—1.1				
" 30...	30.8	32.1	—1.3	"	45.9	47.0	—1.1				
"	29.9	31.0	—1.1	"	44.7	45.6	—0.9				
April 1...	47.8	48.9	—1.1								
"	45.8	46.9	—1.1								
"	44.7	45.8	—1.1								
" 6...	37.9	39.1	—1.2								
"	36.9	38.2	—1.3								
" 9...	31.8	33.0	—1.2								
"	30.1	31.3	—1.3								

Notwithstanding the apparent constancy of these corrections to M_1 and M_2 *the values are all* 0.°9 *too large* numerically. During the entire series the thermometer remained untouched. Up to the time of the last observation recorded above, no comparisons had been made in the day time.

As soon as day comparisons were commenced it was discovered that the hand fell back about 0.°9 for a falling temperature, and advanced 0.°9 for a rising temperature when the thermometer was rapped. There was therefore always a chance for a difference of 1.°8 between day and night observations. Clearly this difficulty was due to faulty mechanical construction, which has since been partly, but not completely remedied. The true reading can however always be found by striking the case a few sharp blows with a lead pencil.

SECOND SERIES.

It is to be noted in connection with this series that the bulb of "No. 4" is nearly half an inch in diameter, while the bulb of C_1 is quite small. M_1 undisturbed.

MAY 28.					MAY 29.				
No. 4.	C_I	M_I	No. 4—M^I	C_I—M_I	No. 4.	C_I	M_I	No. 4—M_I	C_I—M_I
54°.8	54°.8	54°.5	+0°.3	+°.3	47°.3	47°.3	47°.1	+0°.2	+0°.2
57.3	57.0	56.8	+ .5	+.2	49.3	49.2	48.4	+ .9	+ .8
58.4	58.5	57.6	+ .8	+.9	52.2	51.9	51.0	+1.2	+ .9
58.8	58.5	57.6	+1.2	+.9	59.3	59.2	57.6	+1.7	+1.6
58.9	59.0	58.6	+ .3	+.4	60.8	60.9	59.2	+1.6	+1.7
58.5	58.8	58.5	+ .0	+.3	62.6	62.7	60.9	+1.7	+1.8
59.6	59.6	59.1	+ .5	+.5	63.8	63.7	62.3	+1.5	+1.4
60.4	60.3	59.7	+ .7	+.6	65.6	65.4	63.2	+2.4	+2.2
59.7	60.5	59.7	+ .0	+.8	66.8	66.7	64.7	+2.1	+2.0
61.5	61.2	61.0	+ .5	+.2	68.4	68.6	66.7	+1.7	+1.9
61.2	61.1	60.5	+ .7	+.6	70.4	70.3	68.1	+2.3	+2.2
60.9	61.0	60.3	+ .6	+.7	72.8	72.6	70.1	+2.7	+2.5
60.9	60.7	60.4	+ .5	+.3	......	......	......	......	......
61.9	61.6	60.9	+1.0	+.7	......	......	......	......	......
62.0	61.3	60.9	+ .1	+.4	......	......	......	......	......
62.0	61.7	61.6	+ .4	+.1	......	......	......	......	......
60.3	60.5	60.3	+ .0	+.2	......	......	......	......	......
60.0	59.8	59.8	+ .2	+.0	......	......	......	......	......
......	......	......	......	......	......	......	......	......	......

It appears from these observations that after the reduction for back lash is applied, the correction to M_I is nearly zero up to about 60° and that the value of the correction increases from this point.

THIRD SERIES.

Between March 10 and March 25, thermometers M_3 and M_4 were hung upon the wall of the comparing room at the height of about five feet from the floor. After March 24, M_4 was hung about 30 inches below M_3.

M_3 and M_4 undisturbed throughout the series. The comparisons were made at about 8 A. M., 1 P. M., and 10 P. M.

Date.	Baudin. 8614	8614—M_3	8614—M_4	Date.	Baudin. 8614	8614—M_3	8614—M_4	Date.	Baudin. 8614	8614—M_3	8614—M_4
Mar. 10	29.87°	— .13°	—0. 3°	Mar. 24	27.44°	—0.21°	—0.36°	Apr. 21	39.83°	—1.14°	—0.57°
" 11	29.64	— .19	—0.26	" 24	28.90	— .30	— .40	" 22	40.22	— .65	— .17
" 12	29.92	— .19	— .48	" 25	29.98	— .92	— .42	" 25	43.37	—1.13	+ .22
" 12	30.44	+ .0	— .4	" 25	30.06	— .96	— .39	" 26	42.69	—1.31	— .11
" 12	31.1	— .14	— .34	" 26	29.46	—1.06	— .52	" 27	42.27	—1.08	— .03
" 16	33.40	— .13	— .38	" 28	32.54	— .96	— .44	" 28	41.97	—1.33	— .08
" 16	3 .82	— .38	— .38	" 29	32.24	— .96	— .36	" 28	42.57	—1.20	— .08
" 16	32.32	— .18	— .18	" 31	2.66	— .44	— .19	" 29	42.60	— .90	— .06
" 17	30. 2	— .43	— .38	Apr. 12	35.42	—1.08	— .48	" 30	41.91	— .19	— .19
" 17	30.44	— .00	— .51	" 13	35.57	—1.03	— .38	" 30	42.31	—1.29	— .19
" 19	27.78	— .2	— .37	" 13	35.7	—1.05	— .30	May 1	42.47	—1.13	— .07
" 19	8.22	— .43	— .28	" 14	35.32	—1.18	.43	" 1	42.37	—1.38	— .43
" 2	28.3	— .6	— .57	" 14	35.14	—1.08	— .41	" 2	41.59	— .9	— .56
" 22	27.14	— .31	— .46	" 15	35.68	— .82	— .12	" 3	41.73	— .77	+ .13
" 22	27.63	— .32	— .37	" 15	5.98	— .77	— .17	" 3	41.67	— .78	+ .02
" 23	26.40	— .30	— .40	" 17	35.86	— .94	— .34	" 5	41.63	—1.07	— .17
" 24	28.18	— .3	— .42	" 17	35.56	— .97	— .24	" 5	42.07	— .83	+ .02

It appears from these comparisons:

(a) That there is a nearly constant difference of about 0.7° for the two positions in the comparing room, which differ 30 inches in height.

(*b*) That between 26° and 42° the correction to M_3 is nearly constant while the change in the correction to M_4 amounts to about 0.2°.

FOURTH SERIES.

Observations made for the purpose of determining the comparative sensitiveness of the mercurial and the metal thermometers.

On July 17, 1885, thermometers C_1 M_1 and the new thermometers M'_1 (enclosed) and M'_2 (open) were exposed in the open air at 8 A. M. Three cords were stretched between two projecting walls on the north side of the observatory and the thermometers were suspended from these cords. C_1 was suspended alternately outside and inside of the metal thermometers. C_1 (1) indicates that

this thermometer was nearest M'_1; C_1 (2) that it was farthest from M'_1, the order of the metal thermometers being M'_1 M'_2 M_1.

Metal thermometers rapped before each reading.

Time:	8 h. 0 m.	8 h. 30 m.	8 h. 40 m.	8 h. 50 m.	9 h. 30 m.	10 h. 0 m.	10 h. 30 m.	12 h. 0 m.	12 h. 20 m.	12 h. 37 m.
C_1	74°.4(1)	77°.6(2)	79°.2(2)	79°.1(1)	81°.3(1)	83°.4(2)	84°.5(1)	86°.9(2)	87°.9(2)	88°.4
M_1'	72.2	74.1	7[illegible].8	75.8	80.1	80.8	81.6	83.9	85.8	86.3
M'_2	72.8	74.8	75.9	75.9	80.1	81.6	82.6	83.7	86.3	87.2
M_1	71.3	73.4	75.3	75.3	79.9	80.9	81.7	84.1	86.3	86.8

Removed thermometers to comparing room at 12 h. 38 m. 30 s. Thermometers suspended in comparing room at 12 h. 40 m. 30 s. Temperature of comparing room, 63.°6.

Time:	12 h. 42 m. 0 s.	43 m.	44 m.	46 m.	48 m.	50 m.	52 m.	54 m.	56 m.	1 h. 12 m.	1 h. 14 m.	1 h. 16 m.	1 h. 18 m.
C_1	78°.6	75.8	73.8	71.8	70.1	69.8	68.7	68.2	67.8	65.8	65.2	65.1	65.3
M_1'	84.0	83.8	80.0	79.0	79.2	75.8	74.2	73.0	72.2	66.9	66.6	66.6	66.4
M_2'	76.8	76.1	75.0	74.0	72.8	71.0	70.2	69.8	69.1	66.1	66.1	66.0	66.1
M_1	79.8	77.8	75.7	73.7	71.[illegible]	70.6	69.9	69.7	68.8	65.6	65.2	65.6	65.6

At 2h, 35m, 00s, removed the thermometers to prime vertical room, which had a temperature of about 79.4°

Time:	2 h. 36 m. 30 s.	38 m.	40 m.	42 m.	44 m.	46 m.	48 m.	50 m.	52 m.	54 m.	56 m.	58 m.
C_1	66.2	67.9	69.8	71.3	73.0	74.6	75.2	75.9	76.3	76.9	77.3	77.7
M_1'	66.3	67.4	68.8	69.9	71.6	72.9	73.6	74.2	74.9	75.4	75.9	76.2
M_2'	67.6	69.8	71.4	72.2	73.8	74.8	75.2	75.9	76.2	76.8	77.0	77.2
M_1	66.8	68.4	69.7	70.7	71.8	73.4	73.7	74.1	74.8	75.2	75.5	75.8

Time.	3 h. 0 m.	2 m.	4 m.	6 m.	8 m.	10 m.	12 m.
C_1	78.0	78.2	78.5	78.7	78.9	79.0	79.0
M_1'	76.7	77.2	77.6	77.8	78.1	78.2	78.2
M_2'	77.2	77.5	77.7	77.8	77.9	78.1	78.1
M_1	76.1	76.3	76.6	76.6	76.8	77.1	77.2

3h 13m. Removed thermometers to open air.

Time:	3 h. 17 m.	23 m.	19 m.	21 m.	23 m.	25 m.	27 m.	3 h. 42 m.	4 h. 0 m.	12 m.	30 m.
C_1	85.8	87.7	86 4	87.1	87.7	88.0	88.2	89.1	88 6	88.8	89.5
M'_1	82 4	84.8	83.2	84 0	84.8	85 3	85.7	88.0	88.2	88.3	88.6
M_2'	85.8	87.0	86.2	86.3	87.0	87.2	87.3	87.7	87.4	87.7	88 1
M_1	85.2	86.3	85.3	85.9	86.3	86.2	86.5	87.4	87.2	87.1	87.3

The following general conclusions follow from these comparisons.

(1) For a sudden change of about 25° in temperature, nearly the same length of time is required for all the thermometers, viz., from 30 to 40 minutes.

(2) The enclosed metal thermometer lags far behind the others at the start, but reaches the stationary point at nearly the same time.

(3) The thermometer having a steel bridge is rather more sensitive than the others.

It is to be remarked that thermometer M_1 has been subjected to very rough usage, having been swung repeatedly in connection with C_1. Swinging with a radius of about four feet, the metal thermometer takes the temperature of the air somewhat more quickly than the mercurial thermometer. It should be said also that the zero does not seem to have been changed by this operation.

It would seem that an improvement might be made in the method of mounting the hands. The error of reading due to parallax was frequently as great as 0.3. Wm. A. Rogers.

Harvard College Observatory, July 20, 1885.

DETERMINATION OF AIR TEMPERATURE.

PART I.

An article on this subject published in this Journal in January and February of the present year has called forth from Prof. Wild a rather strong criticism in the May number of the Austrian *Zeitschrift für Meteorologie.* In this paper I desire simply to present in a clear light some of the points in my former paper, partly

misunderstood by Prof. Wild, but chiefly to add the results of a few experiments tried since reading Prof. Wild's paper. I heartily agree with Prof. Wild that a difference in latitude will make a great difference in the relative results obtained from various designs of shelters; many of the points at issue have arisen from this fact.

I recapitulate briefly a few of the more important elements that have thus far entered the discussion. In constructing a standard shelter for thermometer exposure, Prof. Wild seeks to avoid harmful effects of radiated and reflected heat, by double boarding the south side of a rather large, outer, wooden, single louvred shelter, leaving a space between the double boards, which by connecting with a space between the upper and lower roofs, allows an opportunity for the escape of heated air currents. The bottom and north sides of this outer shelter are left entirely open. Within is placed a zinc screen consisting of four overlapping, vertical elliptic quarter cylinders; two opposite quarters are swung upon a central spindle thus enabling the observer to revolve them so as to bring the thermometers to view. The top and bottom of the zinc screen consist of right cones with their elements parallel, these causing a slight tendency toward an upward draft of heated air currents as in a chimney. The principal objection to this shelter is its extreme closeness; for example, with a light south wind there would be no natural ventilation. Again the sun's heat reflected from the single louvres acts in precisely the same manner as would the sun's direct heat upon the zinc screen in the interior, causing it to assume a temperature very nearly that of a black bulb thermometer. Another method of exposure is very unlike this, and consists of a single louvred wooden shelter precisely similar to the outside of Prof. Wild's, but with close bottom and single louvred north and south sides. Such a shelter permits a nearly perfect air circulation from all sides, and, by putting a slight projection on the inside and at the top of each louvre, the access of nearly all rain may be obviated.

For a standard of comparison with shelters, it has been proposed to use bright and black bulb sling thermometers, these to be swung in the shade. If the relation between the air temperature of a spot and the temperatures indicated by black and bright

bulbs in the same spot be known, it would seem possible to obtain the first from observations of the other two. As will be shown, several precautions are essential in the use of this combination, especially if we wish to compare the actual temperature of the air in a shelter with that of the air where the black and bright are swung.

I now desire to take up some of Prof. Wild's criticisms, and make my position clear regarding them.

Use of black and bright bulb sling thermometers. In the experiments given in my former paper, there is a table of readings of black and bright bulbs, in the sun, under an umbrella, and in the shade of a barn. This barn, I think, was much larger than Prof. Wild supposes; it was 30 feet in length and height, and I have no doubt that it cast in November a shade having a temperature nearly 1° lower than that of the air in summer. The sun did not shine upon the north side at all, and since the ground retained some of the low temperature of the night, besides being cooled by the radiation into space from the grass during the day, it is evident that there was a tendency toward a lower temperature of the air on the north side. I think Prof. Wild considers the radiation from grass, which I have just alluded to, as intended for radiation from the bulb of the swung thermometer. I did not intend this at all. A thermometer bulb in free air would not radiate as much heat as the grass, moreover, the effect of such radiation would have been nearly the same both in sun and shade. If the radiation from the bulb in the shade had been at all sensible, the temperature of the still thermometer would have been lower than that of the one in motion, whereas the reverse was the case. The necessity of some absolute measure of air temperature under any and all conditions is very apparent. The sling bright bulb thermometer would seem to be a satisfactory means of obtaining this, if only it could be shielded from harmful radiations from the sun, and from dark heat radiations, or if these could be corrected for in all cases. In making more complete experiments on this question, using black and bright bulb sling thermometers, I found it necessary to abandon all experiments in the open air, because it was impossible to find two adjacent spots having the same temperature, under varying conditions of shade,

sunshine and ventilation. For example, swinging in the sun where there was a gentle breeze, and again where it was calm I found both black and bright more than a degree higher in the second case than in the first. Again, swinging in the shade when it was calm, I have found the bright bulb reading higher than with the sun shining full upon it in a place within a few feet, but having a slight breeze. We must then, if possible, obtain the effect of sunshine and shade upon the bright and black thermometers in a place where there is no breeze.

As a working hypothesis, we may assume that the true air temperature of any spot may be obtained from the indication of a bright bulb, by subtracting the difference between the black and bright bulb, after applying to this difference a correction which may vary slightly under varying conditions of insolation, etc. Or we may express the same by the formula $t_a = t_{br} - c(t_{bl} - t_{br})$. In my previous paper I assumed c, the constant, as unity, being led to do so by some experiments made by Prof. Upton on Caroline Island; Prof. Wild thinks this too small under certain conditions. Prof. Ferrel has made an exhaustive discussion of the problem taking into account the ventilation, and has arrived at a much smaller value than unity under ordinary conditions.

The following readings are taken from a long series of experiments made in a room and in full sunshine. Besides the black and bright bulbs, there was a thermometer exposed in the centre of a Regnault's polished silver cup; this cup had been used in a Regnault dewpoint apparatus, but the cork was removed and the cup suspended by threads attached to the stem of the thermometer; a fourth thermometer had the same exposure as the last, except that the polished silver gave place to a nickel cup with slight polish. The following table exhibits the results:

bright	black	silver cup	nickel
84.2°	+5.7°	+7.3°	+11.7°
83.8	5.9	7.2	12.2
83.4	5.3	6.7	11.0
87.2	7.8	8.2	12.1
87.8	7.7	8.1	12.2
87.8	7.9	8.2	12.8
78.6	4.8	4.3	7.7

Each number represents the mean of several observations. The first column gives the observed mean temperature of the bright bulb, and the other columns give the excess of temperature above that of the bright bulb. The results in the last column are noteworthy, showing that a semipolished receptacle, with a free opportunity for the escape of heated air at the top may at times become heated in the sun to a temperature 6° higher than a black bulb. It was very difficult to obtain the true air temperature at the spot where the instruments were exposed, but the value of the constant in the formula was found to be considerably under unity, lying between .5 and .7; we may assume .6 as a probable approximate value. When exposed to dark heat radiation all the thermometers agreed closely, the difference between the bright and black seldom exceeded .2°. This latter result shows that we cannot depend at all upon the readings of the bright and black bulbs for determining the effect of radiated heat; some experiments with gilded bulbs gave very interesting results, but these are not sufficiently complete to be presented here.

Prof. Wild objects to my use of certain of his comparisons between the sling thermometer and his shelter. In quoting Prof. Wild's results I had no intention of establishing the correctness of either method, but rather desired to show the difficulty inherent in such comparison. My idea was to make general comparison only, in cloudy and clear weather. By referring to the table published in the February number, it will be found that when there were clouds the sling thermometer read higher than the shelter, while in clear weather the reverse was frequently true. Prof. Wild refers to the fact that I used the term midday when there were no observations at that time. This term midday was chosen purposely to represent the middle epoch of sunshine; surely if at 8 A. M., and 1 P. M., a certain result is noted dependent on the sun's heat, we may infer that the same result would be noted at noon if we had the observations. Again, if during a part of the day when it is as hot as, if not hotter than at noon, we obtain a certain result due to the heat, we may infer that the same result might be anticipated at noon if we had the observations. It would have answered my purpose just as well to have used 8 A. M. and 1 P. M., in the one case, and 3:30 P. M. in the other. I think the fact that

on May 15, as night drew on there was no gradual increase in the supposed influence on the sling thermometer of radiation into space seems to indicate no appreciable effect from this cause, though Prof. Wild seeks to explain the anomaly in this way. If Prof. Wild will swing his thermometer at night on the lee side of his shelter, and at the hight above sod of the thermometers inside, he will find on clear nights a slight tendency toward a *lower* reading in his shelter than with the sling. The reason for this is that the zinc has a temperature from 1° to 1.5° lower than the air, because of radiation into space from the north side, and consequently the air inside, tending to assume the temperature of its inclosure, has a temperature slightly too low. I believe it is impossible to obtain a better value of air temperature at night, than that obtained with a sling thermometer. Not much precaution is needed to obviate all evil effects of heat from the person; one can stand on the leeward side of the thermometer if there is a breeze, and in a calm it is only necessary to walk while swinging the thermometer. H. A. Hazen.

ON THE RELATIONS OF METEOROLOGY TO YELLOW FEVER.

I.

The climatic conditions of 1853, *as stated by Dr. Edward H. Barton.*

The question of the origin, or producing cause, of yellow fever has probably engaged more attention than any other of the zymotic diseases; and probably no line of physical inquiry so perseveringly and persistently followed, has yielded less in results of a positive character.

In an examination into the relations of cause and effect, where the former is unknown, but suspected, it is rational to search for a similarity in the suspected phenomena, whenever like effects are manifested.

Our physical welfare is so intimately associated with all that pertains to the atmosphere, that in seeking for any facts or circumstances that may throw any light upon the question of causation of special forms of disease, such as yellow fever—a disease known to exist only within a certain climatal zone—we observe with interest any atmospheric changes, or departures from the

normal condition, which may present any evidence favoring a solution of the unknown problem. In this direction there has probably been no more eminent and indefatigible observer than Dr. E. H. Barton, of Louisiana, whose labors cover a period of more than a quarter of a century, previous to and during the terrible visitation of yellow fever which scourged the inhabitants of the Southern states in 1853.

Dr. Barton himself maintained a meteorological record of great value and completeness, he having first introduced the hygrometer into the system of meteorological observation in Louisiana. But it was not alone in the observation and record of the indications of the several instruments employed that his great work was accomplished. In the successful application of meteorological values to the study of their relations to physiological and pathological investigation, the student of such relations should himself be the observer and compiler of meteorological data, and should be not merely competent to observe and record the indications of the different instruments, but should be also an *observer* in its widest sense—one, who from natural qualifications and training, is accustomed to reason within himself upon the complex and ever varying phenomena constantly presented to his observation.

Dr. Barton possessed these qualifications in an eminent degree, peculiarly fitting him for the task of preparing for the Sanitary Commission of 1854, the climatal and pathological history of the epidemic of 1853. He formulated a theory of causation for yellow fever, or more especially of epidemics, based upon a combination of meteorological and *terrene* conditions which he likened unto a pair of "shears"—neither of whose blades could be operative without the other. In the history of the epidemic of 1853, he pointed out in an admirable manner the existence of these combined conditions in New Orleans during that year.

As the question of sanitation does not belong to the purposes of this paper, I will only state briefly that these *terrene* conditions consisted in very great and primary disturbances of the soil created by digging out a basin, or "head," for the Carondelet Canal. This necessitated the excavation of the soil over an area many thousand yards square, and to a depth of perhaps twenty-five feet. Also in cleansing out and throwing upon its banks, to dry

in the sun, the bottom of the original canal; in dredging the bank canal, deepening the ditches upon certain streets, in the most central part of the city; throwing up earth in the construction of a levee on the lake shore, four miles in the rear of the city; excavations upon miles of streets for the purpose of laying gas and water mains, and for paving; excavations for new buildings, for railroad purposes, etc. Furthermore, at this period there were no fixed regulations for the maintainance of a proper sanitary care of the city. These constituted his "terrene" conditions, which only required a certain combination of meteorological elements to ripen into an epidemic of deadly consequence.

While the meteorological conditions of 1853 were unseasonable, even as early as the month of January—both temperature and humidity being above the normal, which condition continued during the months of February, March and April, it was during the month of May. that these special and remarkable departures from the normal condition were manifested in so prominent a manner that Dr. Barton was enabled, as early as the middle of that month, to predict the terrible visitation which followed.

Following the record into June, we find an augmenting of the special characteristics of a high temperature with high dewpoint, the maximum temperature being several times above 90°; an exceptionally high barometer, and from the 9th of the month thereafter, rain showers of almost daily occurrence. "A stagnant atmosphere and the presence of vegetable mould." "A very great and unusual radiation," says Dr. Barton, "evinced an elemental derangement." During the month of July, the maximum temperature was but 89 degrees, and the average slightly under 80 degrees (a very low temperature for the month of July in New Orleans). The average humidity was 82.5 per cent.—lacking but 17.5 per cent. of saturation.

The average at sunrise was 93 per cent. The barometric pressure, as during the month of June, continued high, being 30.265.

During the month of August the meteorological features of this

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[The average humidity for the month of July in New Orleans, according to a twelve years' showing by the U. S. Signal service, is 72.9 per cent.]

[The normal pressure is about 29.99.]

combination reached their maximum intensity—the maximum thermometer being 91°—average 81.5°—barometric pressure 30.194—less than during the previous month, but still above the normal, with a relative humidity of 87.3 per cent., lacking but 12.7 per cent. of complete saturation, and but 5 per cent. less than saturation at sun rise. Solar radiation reached the maximum for the year on the 19th day of the month, being 148°. The rains during the month were of almost daily occurrence, and *tropical in character.*

Here, then, we have during the month of August the higher values of all those climatal elements which are considered to be favorable to the fomentation of yellow fever poison; and during this month, also, we find the greatest mortality from yellow fever —5,269 deaths; the highest daily mortality occurring two days after the occurrence of the highest solar radiation for the year.

In the month of September there was a decided fall of temperature—the average being 76.2 degrees. This was fully five degrees less than for August, although the *relative humidity continued high*, being 85.7. The number of deaths during this month was 1,066 —hardly more than one-fifth the mortality of the previous month.

Such is a brief resumé of the meteorological conditions accompanying the epidemic of 1853, *evidenced by the instruments employed.*

Appended to Dr. Barton's meteorological table for the months of July, August and September, 1853, are the following notes of his observations during these months:

JULY.

"Much thunder and lightning during the month. Heavy rains alternated with hot sun. Much damp weather.

AUGUST.

"Much thunder and lightning during the month; during the intervals of the heavy rains, a burning sun: cold in shade; hot, damp and suffocating air; more 'calms' than ever before observed; the average force of the wind very small. * * * The gutters, when stagnant water left twelve hours after a rain, had gas bubbling up from below—turbid, discolored."

[The greatest mortality from yellow fever generally occurs in September.]

SEPTEMBER.

"The occurrence of thunder and lightning continued as long as the rains. The north winds and cool, dry weather occurred soon after the middle of the month, greatly abating the epidemic."

These brief notes, which but few observers would have considered worth observing or recording, speak volumes in describing the special conditions of the atmosphere attending the epidemic. Many characteristics are recorded as being peculiar to this year, which are absent or present only to a limited extent, during years of normal healthfulness.

From the records of the Sanitary Commission some facts are obtained which are pertinent to this subject: "An agriculturalist in this city noticed that his seeds failed to germinate, or when they did so, they would sprout up a few inches and then wilt and die from sudden blight. He applied to his neighbors engaged in the same business to replenish his stock, but found they had suffered from the same blighting influence. Many fowls, old and young, died without having appeared to be primarily sick. These influences were not confined to New Orleans, but existed wherever the epidemic prevaded as such. On the coast of Texas fish were found dead in immense numbers.

"At Biloxi, the peaches rotted on the trees; great mortality existed among the fowls; flies and musquitoes remarkably numerous; mould on the trees.

"At Bay St. Louis there was an epidemic among fowls.

"At Bayou Sara, the China trees had a sickly appearance, and their leaves were covered with crustaceous *larvæ*.

"At Centreville, the musquitoes were more numerous than ever before observed; mould very abundant and of a drab color; season unusually wet and heat of sun very great.

"At Lake Providence, fowls were very sickly—many having bumps upon them; musquitoes ten-fold more numerous than ever before known. A peculiar smell pervaded the atmosphere of the place."

Dr. McAlister stated to the Sanitary Commission that "he had never seen such repeated floods, attended with such an excess of thunder and lightning, succeeded by such hot sultry days during the latter part of summer;" and so on *ad libitum*.

Such were some of the atmospheric influences observed during the summer of this most remarkable year, *of which the meteorological instruments gave no indication.* In ascribing the epidemic to a combination of "meteorological and terrene" conditions entirely out of the normal state, Dr. Barton certainly made out a strong case. ISAAC H. STATHEM.

NEW ORLEANS, August 12, 1885.

THE RELATIVE VALUE OF OBSERVATIONS OF ATMOSPHERIC OZONE COMPARED WITH THOSE OF OTHER ATMOSPHERIC CONDITIONS, AND A CONSIDERATION OF THE COINCIDENT RELATIONS OF ATMOSPHERIC OZONE TO SICKNESS.

At the time of its discovery atmospheric ozone was looked upon as matter so well defined, and, theoretically so clearly necessary to the well-being of man, that now it appears somewhat anomalous that questions of doubt should arise as to the value of ozonoscopic observations. These possibly may be due to the fact that inquirers into the subject have not had sufficient data pertaining to such observations, and to other coincident conditions, from which to make proper deductions; also, to unsettled opinions relative to the proper method of taking observations of atmospheric ozone. The best method known, and the one now generally adopted, is the iodide of potassium and starch test, with a scale for comparison of ten degrees of coloration. This method is the one that has been employed by the corps of observers of ozone for the Michigan State Board of Health since 1876, and the one adopted by Dr. Kedzie in his systematic observations since 1878. In December, 1884, the State Board of Health of Tennessee inaugurated the same method for a series of observations through a corps of observers of ozone in different parts of that state. I believe that Michigan and Tennessee are the only states in the Union where systematic observations of ozone by a corps of observers are now being taken by any method, though here and there there are individuals in other parts of the country who are taking such observations at the suggestion of some society, or because of their own interest in the subject.

The principal objection raised relative to the value of ozono-

metric (or ozonoscopic) observations, undoubtedly have reference to errors in the "test." Mr. Fox specifies these as follows:

(1) Impurity of chemicals; (2) of paper; (3) formation of iodate of potash; (4) non-union of the whole of the liberated iodine; (5) changes in the force of the wind; (6) bleaching of colorized test from formation of iodate of potash, excess of moisture in the air, high temperature in the air, (?) a great velocity of the air, a long exposure to the air, sulphurous acid in the air, and true antozone; (7) light; (8) ozonometers faulty in construction (under which head errors 1 and 2 would seem properly to belong); (9) differences of aspect and elevation. This last appears to me to be not indicating error in the test, as usually employed, but rather a difference in the quantity of ozone present, due to differences of aspect and elevation. The germicide properties of ozone are now so well recognized I would think another error might possibly arise from the decomposition of ozone by union with atmospheric germs which might find a nidus for cultivation in the moist starch of the ozonoscope itself. There is another error, dependent more upon the observer himself than upon the test, and that is his inability at all times to distinguish and record the actual *shade* of color represented by the ozonoscope. This error may arise from the amount of light present at the times of reading the test; to the existence of partial color blindness on the part of the observer; or, to the fact of the frequent actual variation in color between the ozonoscope and the colors of the scale. This variation may exist even when the scale is divided into twenty different shades. In a series of observations taken at Ealing, a suburb of London, England, by Mr. Ramsey, editor of the *Scientific Roll*, and at Lansing, Michigan, by myself, at the same hour of the day, where the comparison each time was made with a scale of 10 degrees and one of twenty, the result showed that the ratio of the degrees recorded, by comparison with the two scales, at times widely varied. This shows that too great care in readings cannot be made.

The question thus arises, do the results of ozonoscopic observations approximate the truth sufficiently to be of value? The long series of observations already taken in Michigan seem to fairly prove that the *means* of *these* observations eliminate the errors that

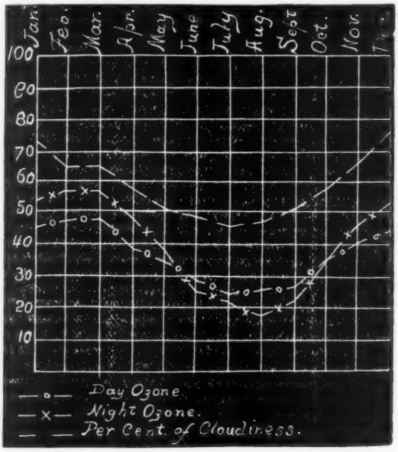
may be present as well as the means of observations relative to other atmospheric conditions eliminate the errors pertaining to them. In a letter which I received from Dr. Henry B. Baker several year ago, he wrote: "I am satisfied that the results of observations of ozone are probably about as reliable as are results of many of the so-called instruments of precision. I think we get nearly as good an idea of ozone as we do of temperature and perhaps better than we do of atmospheric pressure."* Considering the difficulty of arriving at the truth pertaining to absolute, and relative humidity, or the different results obtained relative to humidity by the use of the best known formulæ, these conditions may also be added, as possessing doubtful value, to those specified by Dr. Baker. There are many circumstances tending to produce error in the record of single observations pertaining to all these conditions, but the means of a considerable series of observations pertaining to them show them to be governed by laws so definite that they would seem to possess such value as to render useful the deductions made from them. Yet Prof. Albert R. Leeds claims that there is an apparent lack of connection between the ozone record and those of other meteorological conditions.†

One of the most general of laws observed in regard to atmospheric ozone coincident with other atmospheric conditions is, that during the year, the numerical value of ozone is inverse to the numerical value of temperature. During the season of high temperature there is a low value of ozone, and, during the season of low temperature there is a higher value of ozone. The following diagram, from computations of means of 17 years pertaining to cloudiness, and 9 years pertaining to ozone, from observations published in the Reports of the State Board of Health of Michigan, shows how close the relation is between the per cent. of cloudiness and the amount of day and of night ozone, the scale of ozone being reduced to hundredths. It also shows that the range in the quantity of ozone is greater during the night than during the

*The causes of errors in thermometric readings are well shown in Signal Service Notes, No. XXII, entitled "Corrections of Thermometers," recently published.

†Annals of the New York Academy of Sciences.

day; that the quantity of night ozone is greater than that of the day ozone from the first of October till the middle of May, and less from the middle of May to the first of October. The great activity of vegetation in Michigan from the middle of May to the first of October, in connection with the greater amount of sunshine at that period, probably accounts for the greater quantity of day ozone during that time. This is plainly shown in the diagram. The increased cold at night may account for there being a greater quantity of night ozone at other times of the year, when there is an absence of growing vegetation.

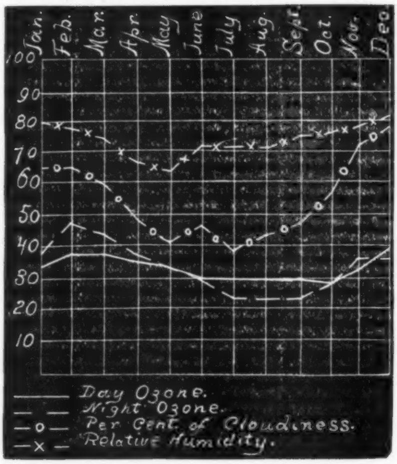


Not only do these conditions obtain for a series of years but they also quite generally correspond with each single year.

The following diagram exhibits the relative value of day and night ozone, per cent. of cloudiness, and relative humidity, deduced from means of observations in Michigan for the three years 1879–81.

The obedience of the test to the influence of impurities of the air in conformity with the general opinion that there is less coloration when the test paper is exposed to such an atmosphere than when not so exposed, is an argument in favor of the value of ozonoscopic observations as an approximate measure of such impurities, and it may be that therein lies their greatest value. It is

a common opinion that in those seasons of the year when there is the greatest amount of oxidizable matter in the air, as has been observed in times of cholera, there is the least evidence of ozone, oxidization being carried on at the expense of the ozone. In an article relative to atmospheric ozone published in the Report of the State Board of Health of Michigan for 1880, and also in the



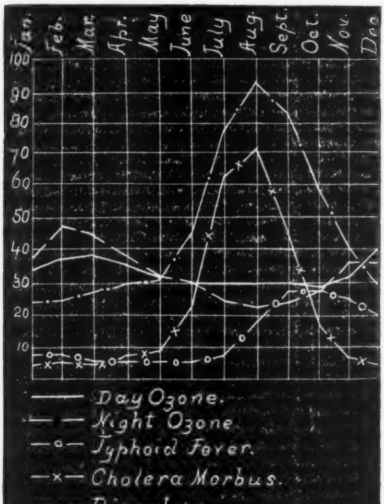
Second Report of the State Board of Health of Tennessee, I gave results of experiments showing the difference between the quantity of ozone found existing near decomposing animal excreta, and that found one hundred feet distant from any such contaminating influence. The following is the exhibit:

Date 1879.	Impure Air.		Pure Air.	
	Night.	Day.	Night.	Day.
June 9	2.5	3.5	4.5	3.5
" 10	2	2.5	3.5	3.5
" 11	1	3	2	3
" 12	2	2.5	2.5	3
" 13	3	..	3.5	..
" 14	3	3	3.5	3
Average	2.3	2.8	3.3	3.2

As insignificant as the difference may appear it is important

enough, in a sanitary point of view, to warn us of the danger of subjecting ourselves to the influence of such an atmosphere.

It is also plainly demonstrated that in seasons of the year when the air is most dangerous from filth, diseases characterized to a great degree by their relations to filth, are most prevalent. To illustrate this point I have computed the monthly means of three years of observations of ozone, and the means, for the same years, of the per cent. of reports, stating the relative prevalence of typhoid fever, cholera morbus, and diarrhœa in Michigan, reported to the State Board of Health, which values are shown in the following diagram:



The respiration of pure ozone, it is well to know, leads to irritation of mucus passages. It is by some considered somewhat doubtful, however, if atmospheric ozone, especially in the quantity detected by any known test, can be said to have any appreciable effect upon animal life in relation to sickness as a cause, per se, as it is impossible to eliminate the effects of other atmospheric conditions existing at the same time, like that of great ranges of temperature, and atmospheric pressure. In general the

natural vitality of a healthy person is such as to enable him to resist, with ordinary precaution, most perturbations of the atmosphere. However, some correlation between the amount of ozone in the air and sickness *seems* to exist. According to observations made by myself in 1877, in regard to ozone and more than one hundred cases of intermittent fever I found that there was more than the average of ozone during those months when there was the smallest number of cases, and less than the average of ozone when there was the greatest number of cases. Dr. Baker has repeatedly observed and shown, in the reports of the Michigan State Board of Health, how close a coincidence occurs between the amount of ozone recorded and bronchial diseases. Such close relations assert the importance of further investigation in this direction. Observations have long since proven that there is little ozone to be found in cities, and it is a significant fact that the death-rate is greater, and sickness is more prevalent in cities than in rural districts. A. W. NICHOLSON, M. D.

AN EXPERIMENT IN WEATHER FORECAST.

[Read before the American Philosophical Society, January 16, 1885.]

The class of '88, in Haverford College, have studied Chase's Elements of Meteorology, with a special view to the formation of trained habits of observation. They have acquired such skill in local weather forecast* that they undertook, early in December, to predict the probable regions of fair and stormy weather for all parts of the United States, on Christmas and New Year's days. The predictions were forwarded to Washington and submitted, through the courtesy of Gen. W. B. Hazen, Chief Signal Officer U. S. A., to the Board of Indications, to ascertain the degree of accuracy.

The following were the grounds of forecast:

1. The mechanical influence of solar and lunar tides on atmospheric currents, which has been tested by sixteen years' investigation and observations at Philadelphia and Haverford College.

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*The verifications, after two months' study, ranged between 74 and 90.3 per cent., the general average being 81.5 per cent.

The normal tendency of tidal pressure, independent of friction, polar and equatorial currents and other disturbing influences, is from the east at syzygy, from the south at the following octant, thus forming a lunar wind-rose, of a like character to Dove's solar wind-rose.

2. The normal percentage of average lunar rainfall on the several days of the lunar month, as deduced from three years' observations of the Signal Service Sergeants (Proc. Amer. Phil. Soc. XIV, 416–8).

3- The Signal Service tables of the winds which are most likely, as well as of those which are least likely, to be followed by rain or snow in each region, during each month of the year.

I had previously stated (Elements of Meteorology, Part I, p. 95), that "a verification of lunar forecasts in five cases out of nine should be regarded as satisfactory. In favorable localities, if due regard is paid to temporary local influences, prediction may often be made for a month in advance, which will prove true, in three cases out of four." The reports which were received from the Signal Office were examined in several different ways, the lowest mean verification of lunar influence for the two days being 59 per cent., while the highest was 100 per cent., as is shown by the following test:

I. *Tests of Lunar Influence.*

a. The tri-daily bulletins of the Signal Service Bureau, show that in 13 of the 22 regions, or 59.1 per cent., there were such differences of barometric pressure between the two days of observation as should be produced by tidal influence, viz.: increased pressure when the normal currents are retarded, diminished pressure when they are accelerated.

β. The florimal relation of temperature to pressure (thermometer rising when barometer falls, and *vice versa*) was shown in 17 of the 22 regions, or 77 per cent.

γ. The tendency to partial reversal of surface currents by friction, in passing over the land, and consequent partial opposition of lunar influence,* was shown in 19 of the 22 regions, or 86 per cent.

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*Elements of Meteorol. Part I. pp. 93-5, Par. 1, 8; Proc. Amer. Phil. Soc. XI, 113.

δ. The rainfall on Christmas day was 1.07 times as great as that upon New Year's day. The lunar normal ratio was 1.04. This represents a verification of 97 per cent.

ϵ. The influence of "favorable localities,' independent of any regard to "temporary local influences," was shown in the Middle Atlantic States, where the verification was 100 per cent., the weather at every station, on each of the days, being such as was foretold.

II. *Tests of Solar Influence.*

ζ. The special report of the Board of Indications, showed a verification of 70.7 per cent. for the fair forecasts and a rainfall, in amounts sufficient to be measured, in 25 per cent. of the regions for which stormy indications were foretold. The full significance of this test cannot be satisfactorily determined, because the normal proportion of stormy winds which bring actual rainfall has never been published.

η. The forecasts which were authorized by the Signal Service tables showed a verification of $1275 \div 19 = 67.1$ per cent. on Christmas day, and of $575 \div 15 = 38.5$ per cent. on New Year's Day, or a general mean of $1850 \div 34 = 54.4$ per cent. In three of the regions at the former date, and in seven at the latter, no forecasts were prescribed by the tables, the wind-deflecting tendencies being from doubtful azimuths. This test, like the foregoing, is affected by the uncertainty as to what constitutes a satisfactory verification of storm-forecasts which cover winds from one-half of the azimuths.

θ. As nearly as could be ascertained from the tri-daily reports, the stormy indications in the Signal Service tables were verified in 65 per cent. for the fair winds, and there was measurable precipitation after 43 per cent. of the stormy winds, the general mean verification being 60 per cent. This would indicate a verification, according to the preceding test, of $54.4 \div 60 = 90.7$ per cent.

ι. The ratio of lunar to solar monsoon influence, which was shown in tests α and η ($59.1 \div 54.4 = 1.086$) agrees very nearly with the ratio which was shown by the winds at Haverford during the past year ($545 \div 514 = 1.06$). Of 1059 observations, 545 were nearer the azimuth which represented the lunar tidal tendency and 514 nearer that which represented the solar monsoon

influence, as given by Coffin (Winds of the Globe, p. 431). This degree of accordance seems to justify the belief that the subsidiary value of lunar normals would be found as great elsewhere as it is at Haverford, for detecting and coördinating the abnormal influences of equatorial or polar, cyclonic or anticyclonic, local or general currents.

III. *Tests at Haverford College for* 1884.

κ. Tidal acceleration of atmospheric currents was accompanied by low barometer; tidal retardation by high barometer.

λ. The percentage, both of stormy winds and of cloudiness, was greater in the lunar stormy cycles than in the fair cycles.

μ. Of the 120 days on which the lunar tidal tendencies were more stormy than fair, 54 were accompanied by measurable precipitation; on 32 other days there were winds from stormy directions; 11 others were cloudy, and on 23 days no special evidence of stormy disturbance was recorded. This represents 81 per cent. of verification by storm or stormy tendency, and 19 per cent. of failure.

ν. Of the 120 days on which the lunar tidal tendencies were more fair than stormy, 74 were fair; on 21 other days there were winds from fair directions and on 25 days there was rain or snow with no special record of fair influence. This represents 62 per cent. of complete verification, 17 per cent. of partial verification, and 21 per cent. of failure.

ξ. Making allowance for one day's possible shifting of fair and stormy tendencies, by the acceleration of equatorial cyclonic currents, or the retardation of polar anticyclonic currents, 85 per cent. of the fair, 71 per cent. of the stormy, and 79 per cent. of all the indications were completely verified. In this test no stormy verification was admitted in which there was not an actual measurable amount of rain or snow.

ο. Of the winds from stormy quarters during the year, 63 per cent. were followed within 24 hours by measurable amounts of rain or snow. Of the winds from fair quarters, 72 per cent. were followed by fair weather for 24 hours, with no measurable amount of rain or snow. The mean verification of all the wind indications was 68 per cent.

π. The comparative value of forecasts, from lunar indications

which might have been foretold years in advance, and from wind indications which are good only for a day in advance, was $45 \div 63 = 71.4$ per cent. for storm; $62 \div 72 = 86.1$ per cent. for fair; $53 \div 68 = 77.9$ per cent. for all.

ρ. The percentage of verification for stormy indications was greatest in winter and least in summer.

σ. The percentage of verification for fair indications was greatest in autumn, and least in winter. There were marked indications, however, of a tendency toward general maximum verification in summer.

τ. The percentage of total verification was greatest in winter, when the thermal disturbance of Moon's tidal action is least, and least in summer, when the thermal disturbance is greatest.

υ. The percentage of verification, both for the fair and for the stormy indications, was greater in the equinoctial semester than in the solstitial.

φ. The conflict of solar daily and monsoon influences with lunar monthly tidal influences was shown in numerous cases of stormy anticyclonism and fair cyclonism which had been overlooked in the daily forecasts from Washington. Predominating solar influence accounted for 32 of the 46 abnormal days during the fair lunar tendencies, and 51 of the 66 abnormal days during the stormy lunar tendencies, or 74 per cent. of the whole.

It would be unwise to draw any positive conclusions from the results of a single experiment, or from observations for a single year at a single station, but there is certainly encouragement for continuing the line of investigation which is here indicated.

PLINY EARLE CHASE, LL. D.

FURTHER EXPERIMENTS IN WEATHER FORECAST.

Since the early part of February, I have received from the Signal Service Bureau the tri-daily weather reports, as well as the daily weather maps. I have also extended my comparisons to Caswell's Meteorological Observations at Providence, from December, 1831, to May, 1860. The reports, the maps, and the comparisons, all show that the Haverford tests, in my "Experiment in

Weather Forecast" (this JOURNAL, April, 1885,) are by no means exceptional. but that similar results are probably attainable in all parts of the United States. I therefore venture to formulate some of the principles of astronomical weather forecast, as follows:

1. The lunar modifications of barometric pressure tend to produce, *a*, high barometer and westward pressure at syzygy; *b*, low barometer and eastward pressure at quadrature; *c*, falling barometer between syzygy and quadrature; *d*, rising barometer between quadrature and syzygy.

2. The solar modifications, through the combined action of heat, attraction and "relative motion," tend to produce, *a*, high barometer and southward pressure at the octants before syzygy; *b*, low barometer and northward pressure at the octants after syzygy; *c*, falling barometer between *a* and *b*: *d*, rising barometer between *b* and *a*.

3. The influences may be most equally divided by counting as fair, all weather which is either fair or clearing, and by counting as stormy all weather which is storm-breeding (including "pet days,") lowering or stormy.

4. Precipitation, during stormy periods, produces a partial vacuum, which is often supplied by an inrush of dry air, producing pet days.

5. The exceptional storms or stormy tendencies, during the prevalence of fair indications, are mostly anti-cyclonic in their origin.

6. The general tendencies, independent of local and monsoon influences, are, *a*, fair for the octants following quadrature; *b*, variable, with predominant anti-cyclonism, for the octants preceding syzygy; *c*, stormy for the octants following syzygy; *d*, variable, with predominant cyclonism for the octants preceding quadrature.

7. The tendency to increasing dampness is greatest, *a*, from the Atlantic Ocean, between two days before and three days after syzygy, with a prevalence of anti-cyclonic currents; *b*, from the Gulf of Mexico, between two days before the first and fifth octants and one day before quadrature, if cyclonic currents prevail; *c*, from the Lakes, between quadrature and syzygy, when the prevailing currents are anti-cyclonic.

8. The reversals of tendencies are mostly due to long continued

polar or equatorial currents. These currents are not apt suddenly to change their character. Therefore, by watching all the influences, sufficiently to see which are normal and which are abnormal, it becomes possible to make forecasts for two or more weeks in advance, which will be verified in four cases out of five.

9. The relations of the daily to the annual barometric oscillations, which were used in 1863 as a ground for estimating the Sun's distance ("Proc. Amer. Phil. Soc.," ix, 283-8; x, 375-6), seem to account for an average daily eastward movement of about 1° in monsoon influences, which has been pointed out by L. A. Sherman, editor of the "Port Huron Times" ("Amer. Meteorolog. Journal," Nov., 1884; "Port Huron Daily Times," Feb. 11, 1885).

The following summary shows the influences, for an entire month, which may be looked for between May 15 and June 15, 1885. It will give readers of the JOURNAL an opportunity to judge for themselves to what extent these influences may be used as a basis for forecast. Observers will confer a favor by communicating the results of their observations to the Secretary of the Franklin Institute.

May 15-17, May 28-June 1, June 12-15, 1 *c*, 2 *c*, 3 (stormy), 4, 6 *c*, 7 *a*, 7 *b*.

May 18-21, June 1-5, 1 *c*, 2 *d*, 6 *d*, 7 *b*.

May 21-24, June 5-8, 1 *d*, 2 *d*, 3 (fair), 5, 6 *a*, 7 *c*.

May 25-28, June 8-12, 1 *d*, 2 *c*, 6 *b*, 7 *a*, 7 *c*.

On account of the friction of surface winds the influence of accelerating and retarding pressures (1, 2) is most often shown by the upper currents, when cirrus clouds are visible.—*Journal of the Franklin Institute.* PLINY EARLE CHASE, LL. D.

LITERARY NOTES.

CIEL ET TERRE, No. 10.

(121) **W. Spring et L. Roland.** *Recherches sur les proportiones d'acide carbonique contenues dans l'air de Liege.* Numerous investigations have shown that the proportionate amount of carbonic acid in the air is sensibly constant; this is a remarkable fact, as it is not probable that the absorption of this gas by the vegetable kingdom is just equal to the variable amount produced by the various phenomena of combustion.

The explanation given by Mr. Schloesing is that the dissociation of the bicarbonate of calcium, held in solution in the waters of the ocean, is sufficient to maintain the carbonic acid of the air at a constant tension. The same principle also accounts for the observed fact that the atmosphere of the southern hemisphere contains less carbonic acid than that of the northern hemisphere (in the ratio of 2.5 to 2.9). The authors, desiring to make observations in a region where the local influences were very marked and well known, and also to learn whether the velocity and direction of the wind, the barometric pressure, the temperature, etc., sensibly affected the composition of the atmosphere, made 266 analyses of the atmosphere at Liege, and found that it contained nearly one sixteenth more carbonic acid than the air at Paris. This they believe to be due to the numerous manufactories in the immediate vicinity of Liege. Accepting as demonstrated that the air at this place is richer in carbonic acid than the air of the surrounding country, a very simple explanation may be given for the local climatic phenomena so familiar to the inhabitants of this section. Magnus and Tyndall discovered that the carbonic acid plays nearly the same rôle as does the vapor of water, thus being a powerful agent for storing up heat. The action of the carbonic acid of the atmosphere is the same as that of window-glass, the luminous solar rays are allowed to pass through, but the non-luminous heat rays cannot escape through the same channel. Other things being equal, the air at Liege during calm weather is warmer than the air of the surrounding country. All factors which tend to prevent a renewing of the air, thus causing a stagnation of the same, also determine the increase in the proportionate amount of carbonic acid; and having given the absorbing power of the gas for the heat rays (which, according to Professor Garabaldi, is 92 times as great as that of air under pressure of 760 millimetres), the authors believe that the exceptional climatic conditions at Liege may be attributed to the excess of carbonic acid in the atmosphere of this place.

(122). **Dr. A. von Dauckelman.** *L'établissement de stations meteorlogiques de premier ordre au Congo.* As but very little is known of the march of temperature in the interior of the tropical countries, and still less is known about the other meteorological elements, this article very properly calls attention to the great increase in our knowledge of meteorology and physical geography which would result from the establishment of a first-class station on the Congo.

(123). **E L.** *La température de la terre.* The law of increase of temperature of the earth according to the depth below the surface is far from being satisfactorily determined. According to observation, to obtain an increase of one degree in the temperature (centigrade), the depth varies all the way from 16.20 metres to 64.80 metres. From results obtained

from 530 stations (classed under three heads, viz.: data furnished by hot springs, mines, artesian wells and borings) Professor Prestwick deduced a mean value of 25.92m. as the depth which corresponds to each increase of one degree in the temperature, but considers this result as an approximation only, and believes that the increase with the depth should be more rapid.

(124). **A. Lancaster.** *Revue climatologique mensuelle, Juin,* 1885. The mean temperature of June, 1885, was 0.4° above the normal, while only twelve days of the month were very warm. We have here an interesting example of the errors which are introduced by simply employing means to determine the character of seasons or any periods of time. A violent storm at Bruxelles on the 25th caused, among other misfortunes, the loss of four human lives. J. M. S.

DAS WETTER. *Meteorologische Monatscheift für Gebildete aller Stände. Herausgegeben von Dr. R. Assman: July,* 1885. *Vol.* 2, *No.* 7.

(125). **Dr. Assman.** *Die Organisation des Gewitter-Beobachtungs: Dienstes in Mittel-Deutschland durch den Verein für Landwirthschaftliche Wetterkunde.* Since the organization of this society, nearly all of the 200 observers have paid special attention to thunder-storms, and since the spring of 1885 this number has, through the untiring efforts of Dr. Assman, been increased to 400, making with the 200 regular meteorological observers a grand total of 500 observers within the territory embraced by the central German states. Besides a careful description of the object injured, observers are also requested to give an estimate of the damages done by the storms, which, during the present year, have been unusually severe and frequent.

(126). **Dr. Lehmann.** *Ueber die Vertheilung der Gewitter in Ost-Thüringen.* This paper is a review of a memoir published in Vol. III of the Geographical Society of Jena. The original memoir contains a discussion of 466 thunder-storm observations made by Dr. R. Schmidt. of Jena, during his twenty-two years of meteorological work. The results are graphically represented by means of a large number of curves. The curve showing the number of thunder-storms in each year is, in general, parallel to the curve giving the mean yearly temperature. Decided maxima appear in the years 1857, 1859, 1860 and 1873. Marked minima occur in the years 1864 and 1875. During the twenty-two years no thunder-storm was observed in November; two per cent. occurred in winter; twenty-eight per cent. in spring; sixty three per cent. in summer, and seven per cent. in autumn. As to the time of day, nine per cent, occurred in the morning, six per cent. at noon, sixty per cent. in the afternoon, twenty-one per cent. in the evening, and four per cent. during the night. In answer to a circular requesting information as to the selective tendency of lightning to strike different kinds of trees, Professor Kirchoff arranges

the results in the following decreasing order: oak and poplar, fir-tree, pine, birch, beech.

(127). **Zur Frage uber die Entstehung des Hagels**. Mr. Aug. Keindorff suggests that as water in a quiet condition can have a temperature below freezing and remain in a liquid state. which immediately changes to the solid state if disturbed, so in the vapor forming the clouds, the falling drops of water can have a temperature below freezing without causing a change from the liquid to the solid state. The vibration of the air after an electric discharge would cause those falling drops of water, which had a temperature below freezing, to congeal, thus forming hail.
S.

(128). **Pilot Chart for August** *Hydrographic Office, Washington.* An unusual number of water-spouts seem to have been observed, no less than twenty three being shown upon the map between the 20° and 40° of north latitude. The drift of the wrecked schooner, "Twenty Four Friends," was, in general, parallel to the Gulf Stream. On March 24 the schooner was in latitude 36°, longitude 73°; by July 7 the position was latitude 46°, longitude 31°. The ice-bergs were numerous in latitude 45°, longitude 50°. The remarks on the tropical cyclones, which at this season of the year are common, refer mostly to indications by means of which the presence of a hurricane at a distance can be recognized. Attention is also called to the fact that if masters of ships would carefully observe the echo they could in all cases detect at once the proximity of icebergs, or other vessels, during foggy weather. S.

(129) **C. [illegible]eeson Prince.** Observations upon the Topography and Climate of Crowborough Hill, Sussex, together with subjects of collateral interest, 1885, 8vo, 104 pp., with cuts and tables. The primary object of this little book is to make known the peculiarly favorable location of Crowborough Hill as a resort for invalids. There are 32 tables of meteorological data given, obtained from observations made (during the years 1874–1884) with two sets of instruments; one set being freely exposed to the open air, the other set inclosed in a "Sterenson stand." Tables one to twenty give the mean yearly and monthly results of the temperature observations. The highest mean temperature of the open air thermometer was 5.6° above the one in the shade. The author holds that, instead of using any device for protecting the thermometers from radiating influences, observations for temperature should be made with fully exposed instruments. The barometric results are given in table 21. Tables 22, 23, 24 and 25 deal with the rainfall; table 26 with the clouds, and the next two tables with the wind. The remaining tables give similar data with reference to the rainfall at Uckfield, Sussex, for the years 1843–1884. The last chapter is on the meteorological character of the several months of the year. S.

(130) **The Modification of Plants by Climate.** *A. A. Crozier*, Ann Arbor, 1885, 8vo, 35 pp. This pamphlet contains so much that is interesting that we feel justified in complaining that it is not better. It has one fundamental fault, and that is its haziness of idea as to everything that is discussed. For instance, by climate the author professes to mean latitude, but actually does mean now temperature, now moisture, now soil, now something else, and he very rarely defines which he means. A discussion of the relations of insolation or mean temperature, or extremes, or of relative humidity, or other element of climate to plant life would be interesting and might be important, but this hazy and ill-defined lumping of them all makes the discussion exasperating. Besides the author does not distinguish varieties and races. He notes the large maize of the Southern States and the small maize of the North, without noting that they are two different races, and that the Kentucky corn can be grown in the North, and the Yankee corn in the South. The author asks for help for further study of the subject. If he means reference to books, the list can be made a very large one. He can consult profitably every monograph of a species of plants, every work on the distribution of plants, and all the numerous horticultural and botanical periodicals. Indeed the literature is probably too extensive by far for its digestion by one man. We would suggest that he could do better by experimentation. The literature is permeated by the haziness above noted. What we now need is a study of the effects of individual meteorological elements on plants. He could attempt to answer by his own observations and experiments to such questions as these: Other things being equal, what is the effect of difference of insolation on the same species of plants? of varying moisture? of varying pressure? Even though he did not succeed in answering a single one of these questions, by his inquiry of nature directly, he could not fail to find much of interest, and it would undoubtedly be of more importance than anything we could draw from the ill-defined and often incorrect statements of the books. H.

(131) **Signal Service Notes, No. XXII.** *Corrections of Thermometers by Thomas Russell.* This pamphlet should be in the hands of every meteorological observer, as it contains many practical hints on the manipulation of thermometers. Attention is first called to the method of applying the corrections, given in the Signal Service correction-cards, to the thermometer readings; several illustrative examples follow. The writer then treats of the changes which new and old thermometers undergo, determined by readings of the freezing-point from time to time. "There is a gradual rise in the freezing-points of mercurial thermometers with age. The rise is rapid at first. Within a week after a thermometer is filled it is sometimes as much as 2.0° F., and in a year after that it may rise an additional 1.0° F. After a number of years the rise may be only a few tenths of a degree. For this reason thermometers are usually

filled about a year and a half before they are graduated. Signal Service thermomters eight years old usually have the freezing-point about 0.5° too high. Sometimes, however, the freezing-point of a thermometer will rise 0.4° F. in a year. When the freezing-point changes, all the corrections of a thermometer are changed by the same amount." The methods for testing the freezing-point and the precautions to be taken in making these observations are next considered; and following this the peculiarities of the alcohol thermometers are discussed. "A source of great annoyance in the use of alcohol thermometers is the continual condensation of the alcohol in the tube above the column. The tube ought frequently to be examined for this. When the "exposed" and minimum thermometers differ much more than half a degree it may be suspected that part of the alcohol column is detached." Following this the writer gives, in detail, several methods by means of which the detached columns, both in the mercurial and alcohol thermometers, can be reunited with the main column. The article closes with a discussion of maximum thermometers. J. M. S.

(132) **Boletin del Ministerio de Fomento de la Republica Mexicana.** Tomo X, Nos. 56-60, June 13 to July 1, 1885. Beginning with number 56, the report of the Royal Commission on the earthquakes of Andalusia is reproduced, and is to continue beyond number 60. It is probably the best account of these earthquakes that we will have.

(133) **Bulletins of the Roumanian Minister of Agriculture, etc.** Bucharest, 1885, Vol. I, Nos. 3 and 4; 8vo, 522 pp. Pages 501-6 give instructions for thunder-storm observations from Sr. Hepites, the director of the meteorological service. The last 16 pages, separately paged, give the meteorological observations, with diagrams, for Bucharest for March and April.

(134) **Epidemic Cholera.** *A Treatise on Epidemic Cholera and Allied Diseases*, by A. B. Palmer, M. D., LL.D., Ann Arbor, 1885, 8vo, 224 pp. This is a monograph on Asiatic cholera. It is timely in appearance and written in a style which will render it comprehensible to any intelligent layman. It is well for everyone to have clear ideas as to what our expected visitor is and how to combat it, and this book will well serve such a purpose. It is of interest to note that its eminent author believes that the choleraic infection may be developed and propagated in the air, thus making its germs one of the organic constituents of atmospheric dust. H.

(135) **Analysis of the Rainfall at Lake Cochituate, Mass**, by Desmond Fitzgerald, M. Am. Soc. C. E. "The same method of analysis has been pursued as that adopted by Mr. Chas. A. Schott in his excellent treatise on the rain and snow in the United States, published among the 'Smithsonian Contributors to Knowledge.'" The results show that on

the whole the rainfall is greater in summer than in winter; but during the year there are three well defined maxima and minima of rainfall the maxima occuring about April, August and November and the minima about January, June, and September.

The data showed that the rainfall of the last ten years was much below the mean, but the time (thirty-two years) was too short to allow any general conclusions to be drawn. H. H. C.

(136) REPORTS.

Report of the Alabama Weather Service, July, 1885. 6pp.

Meteorological Summary of the Indiana Weather Service, July 1885. W. H. Ragan, of De Pauw Univ. Director.

Minnesota Weather Service and Crop Reports, July, 1885, 8pp. Both the average temperature and rainfall of the month were somewhat above the normal.

Missouri Weather Service, July 1885. 4pp., 1 map. The mean temperature was above the normal, and the last decade of the month was very sultry.

Report of the Ohio Meteorological Bureau, July, 1885. 53pp. "The month did not differ materially from that of the two preceding years except in temperature." The mean temperature was 2.5° above the mean of the last three years.

Summary of Meteorological Ob ervations made at the Carson Observatory, Carson City, Nev., July, 1885. 1p. H. H. C.

Monthly Weather Review of the Meteorological Service, Dominion of Canada, July, 1885. 7pp. "The most noticeable features of the month were, first, a well marked period in, and the similarity of, the movements of depressions, which, coming from the west and northwest traveled across the Lakes to the Gulf of St. Lawrence; and, second, extremely heavy rainfalls. The magnets at Toronto throughout the month were generally in a disturbed state.

Annual Report of the Ohio Meteorological Bureau for the year beginning November 1, 1883, and ending October 31, 1884. 127pp. 78 cuts.

Michigan Crop Report for July, 1885, containing a Meteorological Summary of the State Weather Service. 8pp. H. H. C.

CORRESPONDENCE.

DUST-WHIRLS IN NEW MEXICO.

To the Editor:—Doubtless all the the features of the dust whirlwind of India that have been studied and published in great detail could be found reproduced on our desert-plains of the Southwest. I have fre-

quently seen simple dustwhirls, large or small, in crossing these plains and in my recent passage across the Jornada del Muerte in Central New Mexico, I saw an interesting complex whirl. It was seen at about two P. M. About twelve simple whirls, each turning on its own axis, were in a circle of perhaps ten rods diameter and were turning around a common axis. The motion in the individual whirl was decidedly more rapid than that around the common axis. The dust rose to a height of 75 or 100 feet. The general whirl stood nearly still as long as it was in sight—eight or ten minutes—and the whirling motions were irregular and jerky. Very respectfully, M.

EL PASO, August, 1885.

TO THE EDITOR:—Now that the Signal Service Weather Review is at hand, permit me to review my forecasts of local storms and tornadoes published in the Journal for May.

The first column of the following table gives the dates that were thought to be the most likely to be attended by such storms; the third column gives the dates least likely to be so attended, and the second and fourth columns give the number that occured on those dates, according to the Weather Reviews.

April 6	2	April 2	2
" 26	0	" 9	0
		" 14	0
		" 20	4
May 16	7	May 8	0
" 23	0	" 13	0
" 28	4	" 19	0
" 31			
June 5	7	June 8	2
" 13	4	" 16	2
" 19	3	" 30	0
" 23	1		
" 27	1		
July 3	2	July 7	1
" 13	0	" 20	0
" 17	0	" 27	0
" 23	1	" 31	0
Sums	32		11
Means	1.9		0.8

The reason why my theory seems to have failed in April is, that fearing that I could not get my forecasts ready for the April number, I gave less attention to that month than to the others.

During April I improved my method of forecasting somewhat, and selected 30 dates on which 71 tornadoes, etc. occurred.

I have now reason to believe that of this class of storms, those that happen in the West occur within twelve hours of the time of the plane-

tary phenomenon that produces them, and that those in the East occur relatively a little later.

The above is, perhaps, the fairest and most scientific test of storm predictions based on planetary phenomena that has yet been made.

JAMES G. BARDSLEY.

NEPHI UTAH, September 25th.

TO THE EDITOR:—I send the following notes from "Tornado Studies for 1884." Fifty-four charts are given for eighteen days on which tornadoes occurred: Greatest extreme temperature, 100°; least, 20°; average, 7 A. M., 46.54°; 3 P. M., 45.27°; greatest difference of temperature N. and S. of low area, 3.5°; least difference; 3°, except that in five cases was warmer N. of low area; average, fifty-four charts, 12°. At 7 A. M. on seventeen days there was a high area in front and rear of low. One day high area was N.W. and S.W. of low.

J. S. LLEWELLYN.

MEXICO, MISSOURI, Sept. 6. 1885.

PRESSURE CHANGES DURING THUNDER-STORMS.

TO THE EDITOR:—In connection with a note taken from *Nature* which appeared in the last JOURNAL describing some sudden rises of pressure connected with thunder-storms which passed over Berlin, it will perhaps be interesting to state that the barographic curves obtained at Ann Arbor show almost identical phenomena to have been connected with two thunder-storms which passed over Ann Arbor on the evening of June 7th; and the changes of pressure could hardly be better described than in the very words used to describe the changes observed in Berlin: "Before the outburst of the thunder-storm the curves sank slowly, next rose steeply to a considerable height; * * * the curve then maintained itself at a level for some time throughout which the thunder-shower or hail was wont to fall; on the cessation of rain the atmospheric pressure sank steeply * * * ." Eye observations of the barometric height were also taken during the first storm at Ann Arbor, and immediately after the beginning of the rainfall the barometer was observed to rise .07 inch in about ten minutes, then remain nearly stationary for about twenty minutes, when it began to sink.

Preceding this thunder-storm (which came up from the west) the wind had been blowing pretty steadily from the west for an hour or two at the rate of 12 miles per hour, but as the thunder-storm approached it fell to a velocity of about five miles, and coincident with the rise of pressure increased to a velocity of 24 miles per hour which it maintained for about 15 minutes, then in less than an hour decreased to a velocity of about 3 miles having shifted in direction from the west to the east, but soon rose to a velocity of 6 miles again. The phenomena connected

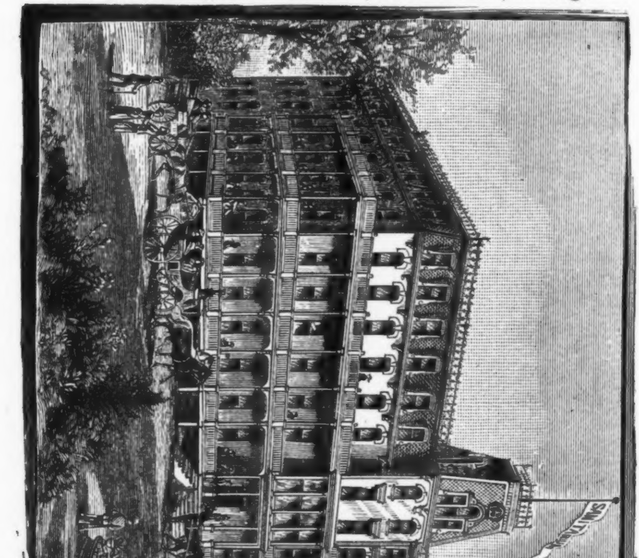
with the second storm were very similar, except that the wind fell from its highest velocity of about 30 miles to an almost calm within ten minutes; but soon rose again to a velocity of nine miles from S. E. which continued for several hours. These changes in wind velocity are in accordance with the supposition that there was an indraught of air toward the cloud in front and rear of the storms, but that immediately under the storm there was an outward movement in every direction, the different effects at the earth's surface in front and rear of the storm being due to the movement of the thunder-storm along the earth's surface.

The short indentations in the pressure curve which appeared to be coincident with lightning strokes in the Berlin storm seem to favor an hypothesis presented by the writer in this JOURNAL pp. 76 and 359 in which it is supposed that pressure changes at the earth's surface may be produced by changes in the electrical potential of the thunder-storm.

In McAdie's article in the last JOURNAL on the *Origin of the Electricity of Thunder-Storms* his whole theory seems to be based on the assumption that "a cloud is a sufficientlygood conductor, to have little difference of potentials at different points." It would have been interesting to some of us if he had given the grounds on which this was based as I have never seen any observations or experiments bearing directly on this phenomenon, but was under the impression that condensed vapor, as it appears in clouds, was not a good conductor, and that the electricity could only get from part to part by convection.

H. HELM CLAYTON.

Medical and Surgical Sanitarium, Battle Creek, Michigan.



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